

The Ordovician–Silurian boundary in the Prague Basin, Bohemia

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Synopsis

The Ordovician–Silurian boundary in the Prague Basin is marked by an abrupt change in facies development and faunal assemblages, without significant breaks in purely marine sedimentation. Shallow marine sandstones and petromict conglomerates of the upper Kosov (Hirnantian) are followed by bioturbated mudstones due to the initial phase of a new transgression, with an abundant *Hirnantia* fauna in the uppermost Kosov. The mudstones are followed by dark graptolitic shales at the base of the Silurian (in the Prague Basin at the base of the *Akidograptus ascensus* Subzone). During the *Parakidograptus acuminatus* Subzone another change of sedimentation appeared as a transition from silty-clay shales to sandy-micaceous laminites. This change corresponds to a local break in sedimentation in the north limb of the Prague Basin and in the Pankrác area, where the break continued to the *Monoclimacis griestoniensis* Zone. The sequence and the succession of faunal assemblages indicate an accelerated rate of transgression just below and above the Ordovician–Silurian boundary. Analysis of the faunal assemblages allows a detailed stratigraphical subdivision of the boundary beds in the Prague Basin and wide international correlation.

Introduction

In Bohemia, the Ordovician–Silurian boundary is well developed in the Prague Basin (Barrandian area). The Prague Basin is a tectonically predisposed linear sedimentary depression in which the sedimentation continued from the lowermost Ordovician up to the Middle Devonian without substantial interruptions (Havlíček 1981, 1982). In the Prague Basin, the Ordovician–Silurian boundary coincides with the boundary between the Kosov and Želkovice Formations. Perner & Kodym (1919) supposed that there was a stratigraphical gap at the base of the Silurian in Bohemia caused by the emersion phase of the Taconic orogeny. Later, the lowermost Silurian graptolite zones, including the *Parakidograptus acuminatus* Zone, were documented in the Barrandian area by Marek (1951) and by Bouček (1953) in an isolated outcrop near Běchovice. These authors denied the existence of the boundary gap east of Prague at Běchovice, but they admitted its presence in the rest of the Prague Basin. Horný (1956, 1960) found the earlier *A. ascensus* Zone along the whole southern limb of the Basin. He recorded that the rocks of the basal Silurian graptolite zones were only absent locally due to minor erosion caused by epeirogenetic movements that represented the aftermath of tectonic activity during the deposition of the Kosov Formation. Havlíček (1981, 1982) explained both the flysch-like Kosov Formation and the change in lithologic development at the Ordovician–Silurian boundary by invoking synsedimentary tectonic movements in the basin.

More recently, basal Silurian graptolite zones have also been discovered in the northern limb of the Prague Basin and the boundary hiatus was verified only in a restricted part of the basin (Štorch 1982, 1986). Investigation of the early Kosov (Štorch & Mergl, in press) has shown the sequence in Bohemia to be very similar to that explained by glacio-eustatic environmental changes (Brenchley & Cocks 1982; Brenchley & Cullen 1984; Brenchley & Newall 1984). The glacio-eustatic conception of the late Ordovician to early Silurian facies and faunal changes (Brenchley 1984; Brenchley & Newall 1984) also appears to explain the Ordovician–Silurian boundary sequence in the Prague Basin.

Sequence of the latest Ordovician

Considerable changes preceding the Ordovician–Silurian boundary event were recorded at the top of the Králův Dvůr Series in the Prague Basin (Štorch & Mergl, in press). The deep water

mudstones of the Králův Dvůr Formation, with deep water faunal assemblages, were followed by coarse grained subgraywackes and silty shales at the base of the Kosov Formation. The high-diversity *Proboscisambon* Community of the uppermost Králův Dvůr Formation was replaced by the low-diversity and short-lived *Mucronaspis* Community (Štorch & Mergl, in press), the last record of which (bivalves and trilobite fragments) occurs in the shale of the lowermost Kosov Formation.

The basal Kosov subgraywackes and shales were succeeded by flysch-like sediments which form most of the thickness of the Kosov Formation. This regressive sequence culminated in the deposition of shallow-water sandstones and petromict conglomerates in the upper part of the formation. In the uppermost sandstone layers a monotonous assemblage of infaunal bivalves provides evidence of intertidal environments (Havlíček 1982). In the uppermost part of the Kosov Formation, the quartz sandstones with shaly intercalations are replaced by siltstones and mudstones. Pale grey, often bioturbated calcareous mudstones and claystones containing a rich *Hirnantia sagittifera* Community occur near the top of the formation. The *Hirnantia* fauna, interpreted by Havlíček (1982) as representing a subtidal environment, has been found only in the eastern part of the Prague Basin. A gradual deepening of the sea seems likely in the uppermost Kosov (Hirnantian) of the Prague Basin.

The cosmopolitan *Hirnantia* fauna found in the uppermost part of the Kosov Formation permits a broad international correlation. In the Prague Basin it was first recorded at Běchovice near Prague (Marek 1963; Marek & Havlíček 1967). Later, it was found at Nová Ves, Pankrác, Řepy and Řeporyje (all within the Prague area) and near Tachlovice. All the fossiliferous localities yielded faunal associations of similar taxonomic composition, but without the depth-controlled variations of the associations reported by Brenchley & Cocks (1982) and Brenchley & Cullen (1984) from the Oslo region, Norway. Lists of the *Hirnantia* faunas from Bohemia were published by Havlíček (1982) and Štorch (1986). The graptolite *Glyptograptus bohemicus* (Marek) accompanies the *Hirnantia sagittifera* Community in Bohemia and supports the international biostratigraphic correlation of the sequence. The layer containing the *Hirnantia* fauna is separated from the first graptolitic shales by at least 0.3 m thickness of mudstone, often heavily bioturbated, with frequent limonite impregnations originating from pyrite weathering (Štorch 1986).

Ordovician–Silurian boundary and lowermost Silurian sequence

In general, sedimentation is continuous through the Ordovician–Silurian boundary in the Prague Basin, in spite of some differences between the separate sections. By using distinctive features of the boundary sequence and also the basal Silurian lithologies, the Prague Basin may be formally subdivided into five areas (Štorch 1986).

The quietest sedimentation, in probably the deepest parts of the basin, is limited to the sections along the whole south limb of the basin (South limb area—Želkovice, Vseradice, Běleč, Vočkov, Zadní Třebañ, Hlášná Třebañ, Karlík, Černošice and Velká Chuchle).

A complete succession starting with the *Akidograptus ascensus* Subzone has been preserved in all the localities (exemplified by the Karlík section, Fig. 1). Clayey shales with climacograptids and rare glyptograptids were recorded even below the first occurrences of *A. ascensus* at Želkovice and Vočkov and could represent the upper part of the *Glyptograptus persculptus* Zone. The *ascensus* Subzone is represented by clayey shales with subsidiary variable siltstones. Sandy-micaceous laminites start within the *Parakidograptus acuminatus* Subzone. The laminites disappear in the western part of the south limb at Želkovice and Vseradice in the *Cystograptus vesiculosus* Zone, and towards the east in the *Coronograptus cyphus* Zone, and sometimes they even reach up to the *Demirastrites triangulatus* Zone (Štorch 1986). In the same way, the onset horizon of siliceous shales migrates in the south limb from the *vesiculosus* Zone at Želkovice to the *Demirastrites pribyli* Zone at Černošice and Velká Chuchle. The Řepy and Běchovice sections differ in having more rapid sedimentation, giving the greatest thicknesses of graptolite zones (Řepy section, Fig. 1) in this part of the Prague Basin. The layer referred to the *per-*

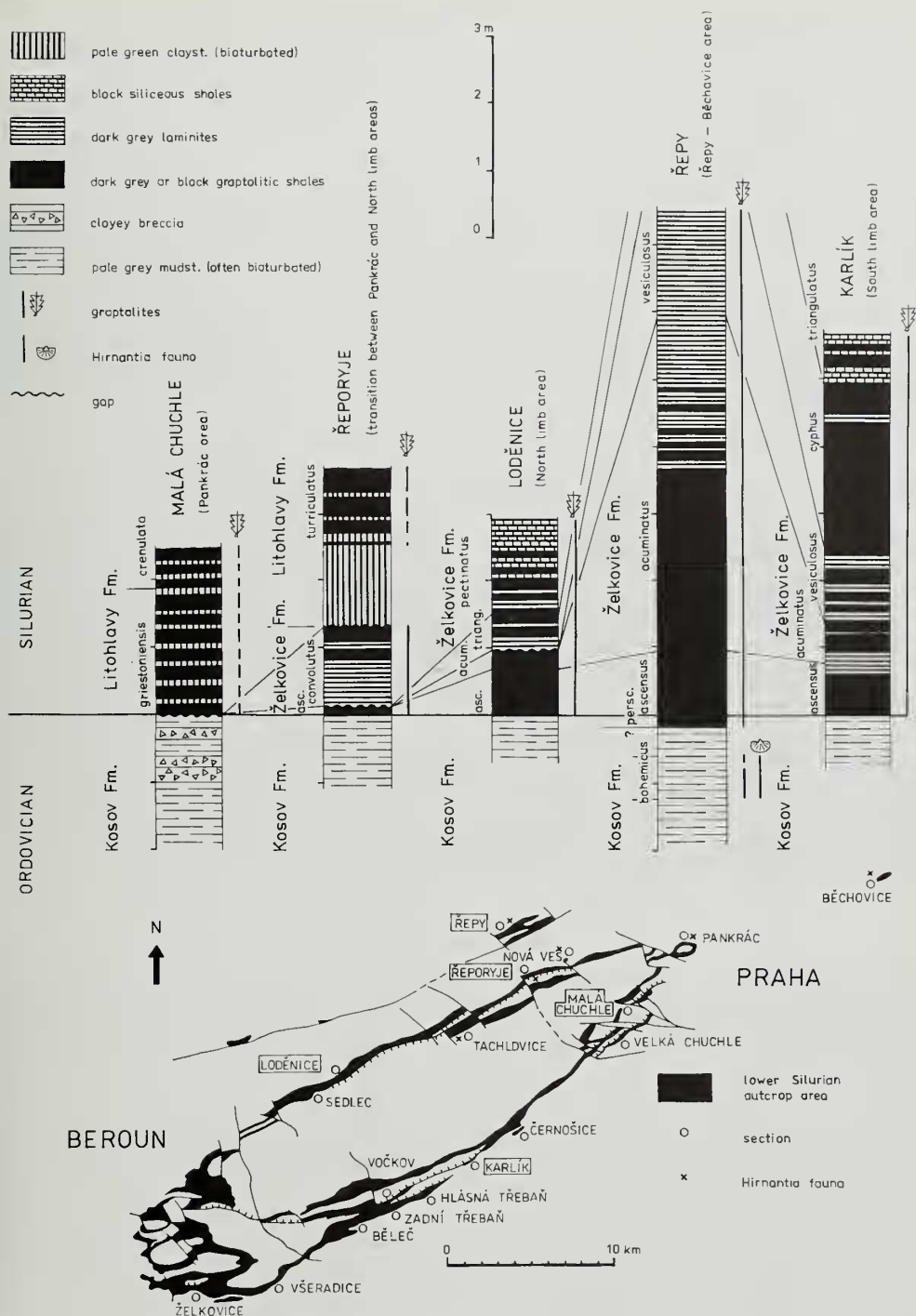


Fig. 1 Lithology, stratigraphy and faunal distribution in selected Ordovician–Silurian boundary sections of the Prague Basin; location of the sections.

sculptus Zone is also developed there. Laminites appear in the *acuminatus* Zone and pass up into the *vesiculosus* Zone.

Detailed studies of both biostratigraphy and lithostratigraphy (Štorch 1986) revealed that the laminites represent more condensed sedimentation than the clayey and silty shales. The onset of laminite deposition in the southern limb of the basin appears to have been synchronous with the start of the break in sedimentation in the *acuminatus* Zone in the north limb of the basin at Sedlec and Loděnice.

The longest break in sedimentation is known from the Malá Chuchle, Pankrác, Nová Ves and Tachlovice sections (Pankrác area). The topmost Ordovician mudstones are followed there by graptolitic shales of the Litohlavý Formation, with upper Llandovery graptolites of the *Monoclimacis griestoniensis* Zone. In this case, reworking possibly took place of previously deposited, incoherent, clayey and muddy sediments of the basal Silurian (*ascensus* Subzone, the lower part of the *acuminatus* Subzone), and perhaps also of the topmost Ordovician (several tens of centimetres in thickness). Near Stodůlky and Řeporyje (Řeporyje section, Fig. 1), this break in sedimentation splits into two shorter gaps. The earlier of them starts above the *ascensus* Subzone and thus supports the explanation of the break presented in different parts of the Prague Basin.

Sedimentation and assumed bathymetric changes

The Kosov Formation, which is about 100 m thick, shows sedimentation which was presumably controlled by glacio-eustatic regression. The subsequent transgression started in the uppermost Kosov and strongly accelerated at the base of the Silurian (Brenchley & Newall 1984). Considerable transgression is also documented by a decrease of the rate of sedimentation at the Ordovician–Silurian boundary. In the Prague Basin, the rate of sedimentation in the lowermost Silurian was approximately calculated (Štorch 1986) to range between 1 m and 7.5 m per 10^6 years in contrast to nearly 100 m per 10^6 years during the Kosov Series (Hirnantian). During the *acuminatus* Zone the transgression caused a further deepening of the Prague Basin and was probably the origin of a fairly intensive bottom current in the deeper central part of the linear depression of the Prague Basin. This current is considered to have caused local breaks in sedimentation, in places perhaps accompanied by mild subaquatic erosion (Štorch 1986). In the sites where this current had less erosive power, condensed sedimentation of laminites occurred, and in the quietest parts of the basin floor there were deposited siliceous shales and silty silicites ('phtanites') which first appeared in the *vesiculosus* Zone.

Stratigraphy

The *Hirnantia* fauna occurs in the upper part of the Kosov Series well above the disappearance of the *Mucronaspis* Community in the basal part of the Series. The *Hirnantia* fauna, which is accompanied by *Glyptograptus bohemicus*, can be referred to the upper Hirnantian, namely to the upper part of the *Climacograptus extraordinarius* Zone or the lower part of the *persculptus* Zone.

In Bohemia, the base of the Silurian System coincides with the base of the *ascensus* Subzone, which is defined by the first appearance of *Akidograptus ascensus* Davies (usually accompanied by *Diplograptus modestus* Lapworth). When compared with the British Isles, the base of the subzone in Bohemia is comparable to the base of the *acuminatus* Zone at the type section Dob's Linn (Williams 1983). In the Prague Basin, the base of the *ascensus* Subzone mostly corresponds to a sudden change in both the colour and the composition of the sediments, in which the pale grey bioturbated mudstones are replaced by dark grey clayey graptolitic shales. However, a low-diversity climacograptid–glyptograptid assemblage has been recorded from several localities at the base of the graptolitic shales just below the *ascensus* Subzone, which is separated by an unfossiliferous bioturbated mudstone from the *bohemicus* Zone beneath. The first assemblage of graptolitic shales below the *ascensus* Subzone is referred to the upper part of

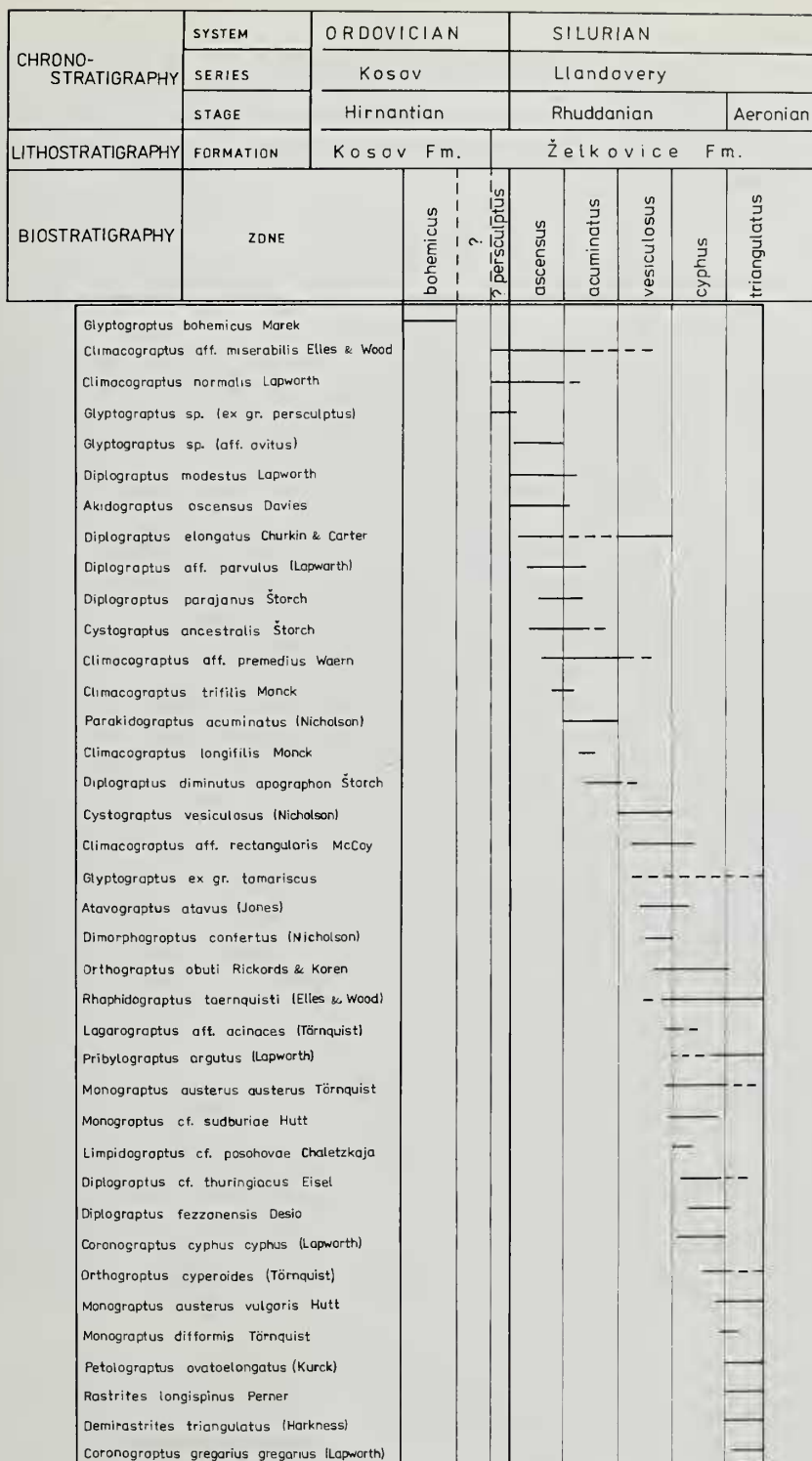


Fig. 2 Chronostratigraphy, lithostratigraphy, biostratigraphy and graptolite species ranges through the Ordovician–Silurian boundary interval in the Prague Basin.

the *persculptus* Zone, in spite of the fact that true *Glyptograptus persculptus* has not yet been found there.

The ranges of graptolites up to the base of the *triangulatus* Zone are shown in Fig. 2. The rich graptolite assemblages of the Prague Basin were briefly described by Bouček (1953), and more recently they have been described by Štorch (1986).

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